

## PATENT SPECIFICATION

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## DRAWINGS ATTACHED

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## (54) TURBO-BLADE CRACK DETECTION MEANS

(71) We, MOTOREN-UND TURBINEN-UNION MÜNCHEN GESELLSCHAFT MIT BESCHRANKTEL HAFTUNG, formerly M.A.N. Turbo G.m.b.H., a German Company, of 5 Dachauer Strasse 665, München-Allach, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described 10 in and by the following statement:—

This invention relates to turbo-blade crack detection means for a turbo machine for early detection of turbo-blade failure caused by incipient cracks.

15 Only in very rare cases will the failure of blades in a turbo machine take the form of an instantaneous complete separation throughout the whole cross-section. Usually, an incipient crack will occur in a particular zone in a particular type of blade, and then will propagate only after a certain period of continued stress to such an extent that a final fracture occurs. It is this final fracture that will then cause the secondary damage which frequently means the 20 complete destruction of the machine.

25 The invention aims at preventing the development of such secondary damage by attempting to detect an incipient crack in a blade as early as possible.

30 Accordingly the present invention provides a combination of a turbo-blade having a resistance wire embedded therein with an electric circuit connected to said wire and operative to detect a change of resistance in the wire 35 due to a crack in the blade.

In a particular embodiment of the invention, the resistance wire is incorporated in a peripherally extending region of the blade or 40 at least in an area of the blade which is thought to be most prone to incipient cracks, this wire normally completing the signal circuit which will be broken if a crack occurs, thereby triggering a signal.

45 It would be possible to connect several blades of one stage of a turbo machine, all blades of one stage or blades of several stages of the machine to a common main signal cir-

cuit. These may be stator as well as rotor blades.

Reference will now be made to the drawing 50 in which the figures are schematic presentations and

Figure 1 is a view of a blade with a warning signal circuit wire according to an embodiment of the invention,

Figure 2 is a cross-section through the blade 55 of Figure 1,

Figure 3 is an arrangement according to an embodiment of the invention fitted to a set of stator blades, and

Figure 4 is an arrangement according to an embodiment of the invention fitted to a set of rotor blades.

Referring to Figure 1, in a blade 1 an area or region marked by shading 2 is thought to be especially prone to incipient blade cracks and blade failures. A resistance wire 3 is incorporated in blade 1 and routed through a peripheral blade area 2. Resistance wire 3 leaves the blade via blade root 4 and is, at terminals 5, 6, connected to a circuit comprising an electrical warning circuit (such as a circuit 7 shown in Figure 3) to which a signal indicating unit is connected. The indicating unit may be one with an optical or acoustic warning signal. It is indexed 8 in Figure 3.

Within area 2, the connection between resistance wire 3 and blade 1 must be such that resistance wire 3 will be broken when a blade crack occurs in area 2, an example for such a blade crack being shown by line 9. When this blade crack 9 occurs, the resistance in the warning circuit is suddenly and considerably increased, thus triggering the warning signal. In this way it will be possible to readily detect a blade crack from the outside and to remove and replace the blade before a blade failure with the possible consequent destruction of the complete machine.

In the embodiment of Figure 3 all blades 1 of a stator are connected to the common warning circuit 7 with indicating unit 8, and in the embodiment of Figure 4, all blades

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1 of a rotor are connected to a slip-ring contact 9'.

**WHAT WE CLAIM IS:—**

- 5      1. A combination of a turbo-blade having a resistance wire embedded therein with an electric circuit connected to said wire and operative to detect a change of resistance in the wire due to a crack in the blade.
- 10     2. A combination according to claim 1, in which the resistance wire is embedded in the blade so as to extend through blade areas most susceptible to cracking and in such manner that cracking in any of said areas will tend to break the wire.
- 15     3. A combination according to claim 1 or claim 2 wherein the wire extends along a peripheral region of the blade.
- 20     4. A combination according to any one of claims 1 to 3 wherein said electric circuit has visual or acoustic means for indicating the presence of a crack.
5. A turbo-machine having a combination

according to any one of the preceding claims.

6. A machine according to claim 5 having several or all the blades of one or more stages so constructed, interconnected, and connected to one such electric circuit.

7. A turbo-machine having a combination substantially as hereinbefore described with reference to Figures 1 and 2 together with Figure 3 and/or Figure 4 of the accompanying drawing.

8. A combination according to any one of claims 1 to 4 substantially as hereinbefore described with reference to Figures 1 and 2, together with Figure 3 and/or Figure 4 of the accompanying drawing.

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